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Uncertainty of tunneling microscopy measurements of the field emission from multilayer nanostructures

E.V. Panfilova[1], A.B. Syritskii[2], A.R. Ibragimov[1]

[1]*Department of Electronic Technologies in Mechanical Engineering, Bauman Moscow State Technical University, 105005, Moscow, Russia*
zotaak@mail.ru

[2]*Department of Metrology and Interchangeability, Bauman Moscow State TechnicalUniversity, 105005, Moscow, Russia*

The paper presents the results of scanning tunneling microscopy (STM) investigation [1] of electron field emission (FE) from multilayer nanostructures based on silica opal film Cr-SiO_2-Au-C. Opal film was deposited in colloidal solvent [2], other films – by vacuum deposition [3, 4]. We discuss the problem of uncertainty of measurements of the field enhancement factor or gain coefficient k by using the current I versus applied voltage V characteristics of the emission [5]. K factor is defined as the ratio of the electric field at the nano-edge to the applied to the gap electric field. A large k factor allows emitters operate at a small applied voltage.

Uncertainty of measurements has been estimated according to ISO/IEC GUIDE 98-3:2009 Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995). In the experiment the k factor was calculated by means of the graph of FE in Fowler–Nordheim coordinates. The FE regime was observed for higher applied voltage (Fig. 1).

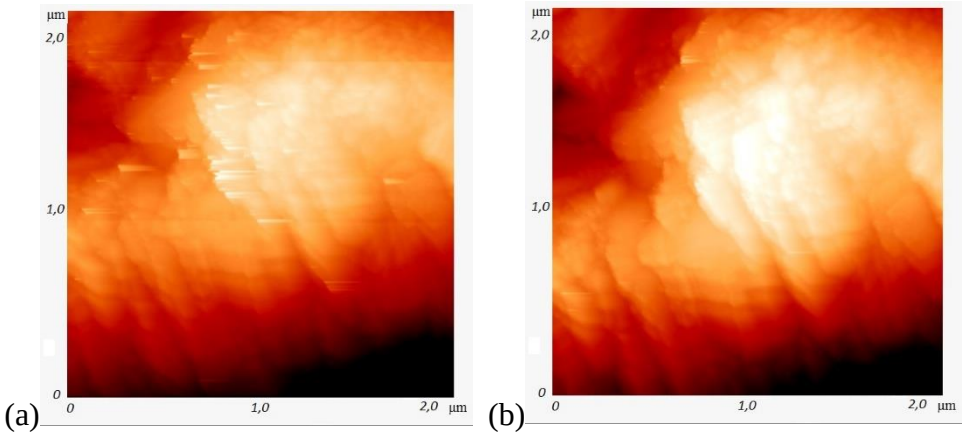

Figure 1. The dependence of STM-images on the regimes of the current I versus applied voltage V curve: (a) tunneling regime, (b) FE regime.

Type A uncertainty was calculated from a series of observations and measurements of the tangent of inclination of the FE graph. Type B uncertainty was evaluated using available information in handbooks and technical passport. At specified level of confidence of 95% the value of estimated expanded uncertainty was approximately 10%. The phenomenon of uncertainty in STM measurements of k factor is mainly related to the reproducibility of the films deposition process and unevenness of multilayer structure. The main application of this methodology is laboratory testing of the emission nanostructures.

1. A.S. Komshin, S.R. Orlova, *Meas. Tech.*, **59,** 589 (2016).
2. V.L. Kuleshova, E.V. Panfilova, E.P. Prohorov, *2018 International Russian Automation Conference (RusAutoCon)*, 1-5 (2018).
3. S.V. Sidorova, M.A. Pronin, A.A. Isaeva, *2018 International Russian Automation Conference (RusAutoCon)*, 1-4 (2018).
4. Y.V. Panfilov, L.L. Kolesnik, V.T. Ryabov, S.V. Sidorova, *J. Phys.: Conf. Series*, **872**, 1 (2017).
5. A.B. Syritskii, E.V. Panfilova, *IOP Conf. Series: Mat. Sci. Eng.* **443**, 012035 (2018).